1. PURPOSE. This order identifies design and operational characteristics of the equipment required to support the maintenance program for the Airway Facilities Service. This program shall be used in all phases of new and replacement system acquisitions, maintenance, and operational life. The order characterizes the maintenance program and assigns responsibilities for its implementation. The order is divided into two parts; Appendix 1, Design Characteristics, and Appendix 2, Maintenance Operational Characteristics.

2. DISTRIBUTION. This order is distributed to branch level in the Airway Facilities, Systems Research and Development, and Logistics Services, to division level in Air Traffic Service, Office of Flight Operations, Office of Personnel and Training and Office of Systems Engineering Management in Washington headquarters; and information copies to branch level in the FAA Technical Center and Aeronautical Center; to branch level in regional Airway Facilities divisions, to division level in regional Air Traffic and Logistics divisions; and to all Airway Facilities sector field offices, sector field units, and sector field office units.

3. BACKGROUND. The Airway Facilities Service has been faced with increasing personnel and resource demands as the inventory of NAS facilities/equipment continually increases and changes to keep pace with the growth and needs of aviation. Budget and personnel position ceilings dictate that the manner by which Airway Facilities maintains facilities/equipment and utilizes its resources for acquisition and maintenance of systems must be changed so that Airway Facilities shall be able to provide better and more efficient service with improved performance. Order 6000.27, Transmittal of Maintenance Philosophy Steering Group (MPSG) Report (RIS: AF-6000-OT), provides the basic philosophy for the new concept. Implementation of this concept and successfully changing the manner in which Airway Facilities maintains facilities/equipment in the field requires incorporation of this program into the earliest phases of systems design, planning and implementation.

4. DEFINITIONS.

a. Acquisition. The act of acquiring hardware, software, spare parts, supporting documentation, testing, site preparation, flight inspection, and initial training.

b. Corrective Maintenance. Action required to repair a single failure comprised of all those individual maintenance tasks involved in the maintenance procedure (e.g., fault localization, isolation, repair, checkout, etc.)

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systems and to perform repairs of Line Replaceable Items (lri's) removed from remote facilities during onsite repair activities.

f. Work Center. The reporting point and duty station from which maintenance technicians begin routine and/or restoration visits to remote facilities and store supplies.

g. Line Replaceable Item (lri). The designated field replaceable item.

5. OBJECTIVES. The objectives of the new maintenance program are to ensure that the overall mission needs are met and the total overall cost of ownership is minimized by incorporating a new method of designing, maintaining, and supporting Airway Facilities equipment. This requires the process of translating mission needs, operational and support requirements into detailed engineering design requirements, that provide minimized Life Cycle Costs (lcc). Design requirements shall be developed through an interactive process which analyzes requirements and lcc to converge on a totally optimized system.

6. GENERAL DESIGN FOR THE 80's. The 80's maintenance program is based on conversion of all equipment to state-of-the-art technology, use of remote maintenance monitoring of equipment and centralization of the work force with minimum preventative maintenance tasks. The primary consideration in design of the facilities and equipment is their ability to perform the intended function reliably. The concept allows the maintenance of an evergrowing inventory of equipment to be performed by a relatively small, multi-skilled technical work force. Repetitive and administrative tasks normally done by technical personnel are to be accomplished by a computer, thereby leaving the technician free to perform high level, decision oriented work. The central provisions of the program is the ability to remotely monitor the performance of a facility, measure equipment parameters, predict imminent failures, and to make compensating adjustments or corrections. This requires sensors at the remote facility feeding up-to-date information over a telecommunications network to a central processor, located at an ARTCC, terminal facility, or sector office. It would collect, process, analyze data, and present the necessary information to the technician via a portable terminal at the remote facility or where there is access to a telephone or stationary terminal at a work center. The level or degree to which these functions would be accomplished would vary by facility type.

b. The Engineering Divisions (AAF-300, 400, 500) have program management responsibilities for: development of the specific equipment maintenance program, performing the requirements analysis which forms the basis of the equipment specification, and assuring the adequacy of the deliverables required by the specification.

c. The Airway Facilities Program Division (AAF-100) has program management responsibility for: manpower, training, staffing, and data management of the maintenance program.

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(1) Remote Facilities. A facility is termed "remote" due to inaccessibility, geographic location or by FAA designation. Most facility types (VORTAC's, RCAG's, ILS's, ASR's) are classified as "remote facilities." These facilities shall require very few visits by personnel for repairs. Onsite maintenance will consist primarily of periodic checks of equipment and monitor performance, cleaning of equipment, and removal and replacement of modules. The facility shall be designed for simplicity. Given a design choice, complexity shall be placed in the central maintenance facility where maintenance is most readily available. Provisions shall be included for remote monitoring and control of the remote facility.

(2) Central Maintenance Facility. The Central Maintenance Facility shall contain the centralized remote monitoring and control hardware to ensure availability of the systems function. The central facility is equipped to repair modules, perform module level modifications, conduct performance tests on subsystem components associated with facilities and RMM system.

b. The Remote Maintenance Monitoring System (RMMS). The RMMS shall be used to remotely monitor, and automatically report on facility performance and provide control of some operations. The RMMS will provide increased facility/equipment availability and minimize routine equipment site visits by the technicians. The RMMS shall be used to effect savings in travel and to better utilize technical personnel as an important, limited sector resource.

c. Documentation Actions. The RMMS shall be designed to minimize routine documentation actions and automate prepared facility logs, outage reports, and other documentation.

2. SYSTEM DESIGN. Equipment procured by the Airway Facilities Service will be influenced by several design characteristics. These characteristics which must be balanced against each other to optimize the system design and life cycle costs include: availability, functional performance, reliability, standardization and flexibility, expandability and adaptability, remote and central maintenance facility concept, maintainability, the environment and energy conservation.

and operating costs of the system. Life Cycle Cost (lcc) analyses must be performed in order to optimize system design requirements vs. costs.

b. Site Visitation. All remote equipment shall have a minimum design goal of one maintenance visit per quarter. Site visits may be made by teams composed of electronic and environmental technicians. Maintenance actions include both corrective maintenance (cm) and periodic maintenance (pm).

c. Standardization. In order to reduce lcc of systems the possibility of procuring standard equipments should be examined on a system basis. Consideration shall be given to existing equipment inventory, technical skills, training and support equipment. Special purpose hardware shall be reduced or eliminated. The resulting systems are to be more dependent on the software and firmware that adapts the standard elements to the functions required. The two forms of standardization are major hardware elements used in several functional systems and major software and firmware elements within the system.

d. Flexibility and Expandability. System design shall provide for flexibility and expandability to adapt to future requirements. Provisions should be made for adding or changing future functional requirements, especially as new equipment are added to the system. The design of both hardware and software should be modularized so that they are less time consuming and less costly to modify.

e. Adaptability. System design shall provide for adaptability such that the standard system elements will meet local requirements without modification. They should be accomplished by standard hardware or software adaptations.

f. Maintainability. Maintainability features shall be included in the design of equipment and systems. These features are to reduce repair time by enhancing the ability of the technician to diagnose a malfunction rapidly, to identify the defective part or module, and to replace it quickly. The types of features that shall be considered include: internal online diagnostics that can isolate the failed module and automatically reconfigure to a redundant element; modular design for redundancy and ease of maintenance replacement for later offsite repair; built-in test equipment; remote monitoring and control, and diagnostic

for trade-off studies to evaluate the cost effectiveness of specific levels of built-in diagnostics.

(2) Modularity. Shall be considered in design. Modularity is achieved through functional design by partitioning the system into physically and functionally self-contained units to facilitate fault isolation, removal, and replacement. Partitioning enables equipment units, assemblies, and subassemblies to be designed as discrete items or modules. The application of modular design allows the isolation of faults to a unit which may be removed from the equipment and replaced with a spare module. The faulty module shall then be repaired at the central maintenance facility minimizing online maintenance action.

(3) Remote Maintenance Monitoring System (RMMS) Functions. The following functions are to be implemented at the present time:

(a) Monitor and alarm.
(b) Certification.
(c) Remote control.
(d) Recordkeeping.
(e) Trend analysis.
(f) Failure anticipation.

Future functions are:

(g) Diagnostics.
(h) Remote adjustments.
(i) A problem/solution file.

(4) Remote Maintenance Monitoring System (RMMS) Design. The RMMS shall consist of the following:

(a) A maintenance processor subsystem (MPS) that functions as the "master station" RMM central processor.

(b) A telecommunications network (tcn) that enables telecommunications to and from the monitored facilities/equipment to the MPS.

g. Minimum Periodic Maintenance. Equipment design shall minimize the number and frequency of periodic maintenance (pm) tasks. The resultant system characteristics shall minimize periodic maintenance tasks and minimized numbers of facility/equipment site visits. Periodic maintenance tasks and periodicity shall be flexible enough to allow for periodic maintenance to be accomplished in conjunction with corrective maintenance (cm) tasks. Upon completion of the corrective maintenance and periodic maintenance tasks, the pm clock is reset, to provide the appropriate time interval until the next pm visit or cm, whichever comes first. Remote equipment has a minimum design goal of one maintenance visit per quarter.

h. Environmental and Other Support Equipment. Alternatives for environmental equipment shall include RMM capability, extended time between preventive maintenance actions and failures, and reduced time to diagnose, troubleshoot and repair. Battery backup shall be considered in lieu of engine generators for particular equipment application.

i. Energy. Systems shall be designed for energy efficiency. Renewable energy sources (solar, wind, etc.) for system power requirements shall be considered based on lcc analysis. This analysis shall be made during the early design stages and should clearly demonstrate that the renewal energy source will not lower the overall system reliability.

incorporated in the system development process and will document support requirements such as, spare/repair parts, training, maintenance procedures, remote monitoring equipment, test equipment, and other support items for the system.

b. Definition of Maintenance Levels. Availability and reliability of Airway Facilities are to be the prime functional responsibilities of field maintenance personnel. Therefore, the following maintenance levels are established to effect maximum responsiveness, productivity, and efficiency in utilization of maintenance personnel and resources.

(1) Onsite Maintenance. Onsite maintenance shall be conducted in accordance with policy and guidance defined in the applicable maintenance directive (maintenance plan) for the respective airway facility, system, or equipment. It will consist of routine periodic maintenance and repair actions as required to maintain the airway facility in a fully operational status. The term "airway facility" includes the maintenance of all primary, secondary, and ancillary equipment or systems that are necessary to support the total facility. Onsite maintenance shall also include nonroutine or repair actions in the form of system analysis of faults, troubleshooting, and testing in accordance with technical manuals, logic diagrams, or manufacturer's handbooks to identify faulty components, units or assemblies, and to effect repair.

(2) Central Maintenance Facility (cmf). Maintenance of lri's will be accomplished in centrally located sector facilities which are equipped and staffed to repair modules, conduct performance tests on subsystem components, and perform module level modifications on facilities and systems within their area of responsibility. The cmf will be equipped with specialized test equipment and tools, spare parts, and specialized diagnostic hardware/software required for repairing lri's that are removed in accomplishment of onsite field maintenance activities.

In addition, the cmf will provide for the calibration of test equipment and RMM systems which include the RMM equipment at the remote sites. LRI's

as well as the performance of highly complex maintenance actions which are beyond the resources of the field maintenance organization. The Depot also serves as the major logistics support facility for field accomplishment of onsite and cmf maintenance activities.

2. MAINTENANCE ORGANIZATION.

a. Airway Facilities Sectors. Airway Facilities sectors are the principal element in the field maintenance program. Typically, they have a complement of approximately 100 people and provide onsite field maintenance, central repair facility capability, first level engineering support, logistics support, training, and administrative support under the management of a sector manager.

b. Regional Offices. Manages and provides overall policy guidance in the maintenance program to sectors, and manages engineering activities, prepares cost estimates, identifies equipment and material for establishment program.

c. National Field Support Group. Provides second level engineering support with an emphasis on resolution of systemwide and national problems associated with system integration and implementation as well as engineering support for the resolution of difficult local problems.

d. Headquarters. Administers and manages the technical aspects of the NAS. Develops policy and procedures and is responsible for the acquisition and development of major NAS systems.

3. MAINTENANCE MANAGEMENT SYSTEM. The maintenance management system is a composite of the technical and technical management information necessary to manage the NAS. A large percentage is automated and interactive. Application of this data assists in assessing performance analysis of trends, reporting status, and scheduling administrative and technical functions.

4. SUPPORT. From the view of an operational NAS facility, support is multifaceted. It includes documentation and analytical capabilities, provisioning of spare/repair parts, test and calibration equipment, and engineering assistance.

special items which are not cost effective to service at cmf's. Responsibility for repair and the allocation of necessary test/calibration equipment and spares will be identified during the acquisition part of the maintenance planning activity.

d. Engineering Support. Support of an engineering nature to solve difficult problems and establishment of new systems is to be provided by the sectors. Each sector has this capability within its organizational structure. This resource will be supplemented by regional capability. The National Field Support Group (NFSG) will provide second level engineering support for resolution of problems that could not be resolved at the sector level and those of a systemwide nature.

5. SERVICE CERTIFICATION. Certification of NAS facilities shall be based on officially approved tolerances and limits for specified system parameters. These parameters indicate the quality of the service being provided to the user. The act of determining that these parameters are within prescribed tolerances and limits, is termed service certification.

6. METHODS OF CERTIFICATION. Certification of NAS facilities entails a documented judgment by competent authority, that officially approved tolerances and limits for critical system parameters are being met. These parameters are indicative of the expected quality of service being provided.

a. Systems that employ remote monitoring have two methods of certification. Remote facility certification accomplished through the RMM equipment on a regular basis by polling routines; or on demand for the purposes of satisfying incident procedures; and a less frequent scheduled requirement for onsite certification of the equipment and verification of normal operations of the remote monitoring equipment.

b. Systems that are not remotely monitored are certified by a technician onsite, physically measuring the critical parameters. This is accomplished on a scheduled basis or as dictated by incident procedures.

7. INSPECTIONS.

a. Technical Inspections. These are systematic onsite inspections on a periodic basis. The frequency and scope of these inspections may be altered by performance assessment.

(3) Special - Required by administration incident investigations procedures.

8. STAFFING AND TRAINING.

a. Staffing. Staffing is based on the number of facilities and structures to be supported and the environment in which they operate. The number of personnel to support new equipment is determined by qualitative and quantitative factors. Standards for establishment of staffing levels will be based upon the analytical nature of the positions as well as traditional, direct-work categories.

b. Training. FAA technicians have the comprehensive knowledge of theory and hardware necessary to perform analytical and corrective efforts in a manner demanded by the criticality of the NAS.

(1) FAA Academy Training. The FAA Academy in Oklahoma City conducts resident in-depth hands on training on specific hardware/software systems. They also develop multi-media courses to support sector training.

(2) Airway Facilities Sector. The sector conducts prerequisite and refresher training with multi-media training materials. These materials are designed to support the needs of predevelopmental, developmental, and journeymen technicians.